Knowledge Questions from Knowledge Graphs

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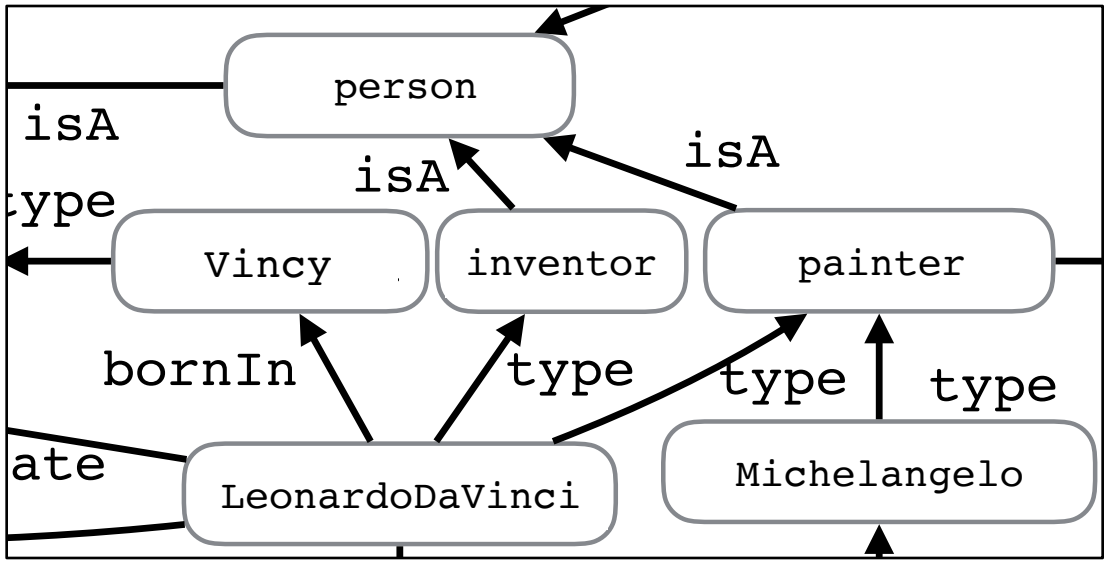
Knowledge Graph → Knowledge Question



Which Italian Renaissance painter and inventor created Mona Lisa?

Topic: Painters
Answer: Leonardo da Vinci
Difficulty: Easy
Distractor Hard: Michelangelo
Distractor Easy: Vincent van Gogh

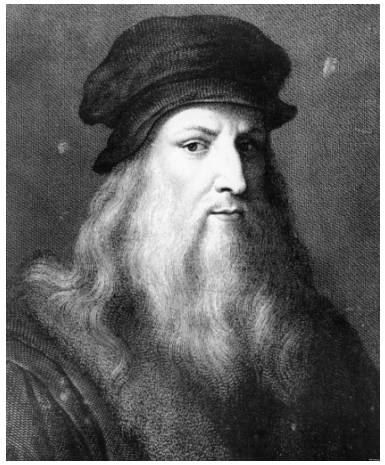
Question Generation Applications

- **Education** (e.g., learning assessment tests for students)
- **Professional training** (e.g., questionnaires about products for new employees)
- **Leisure** (e.g., quiz games)
- **Human Computing / Crowdsourcing** (e.g., generate test questions as honey pots)

Benefits of Question Generation Automation

- Saves human resources
- Enables to generate questions on large scale
- Automatic answer evaluation through multiple-choice
- Evaluate user expertise by inferring question difficulty automatically

“Bottom-up” Question Generation



Answer Entity

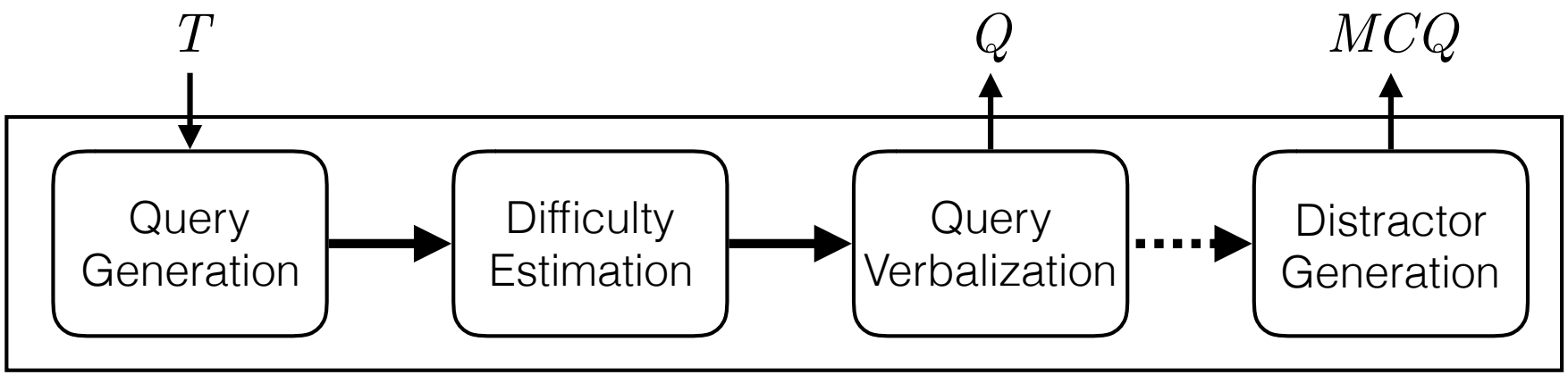
```
SELECT ?x WHERE {
?x created Mona_Lisa .
?x type inventor .
?x It._Renaissance_painters
}
```

Triple-Pattern Query

Which Italian Renaissance painter and inventor created Mona Lisa?

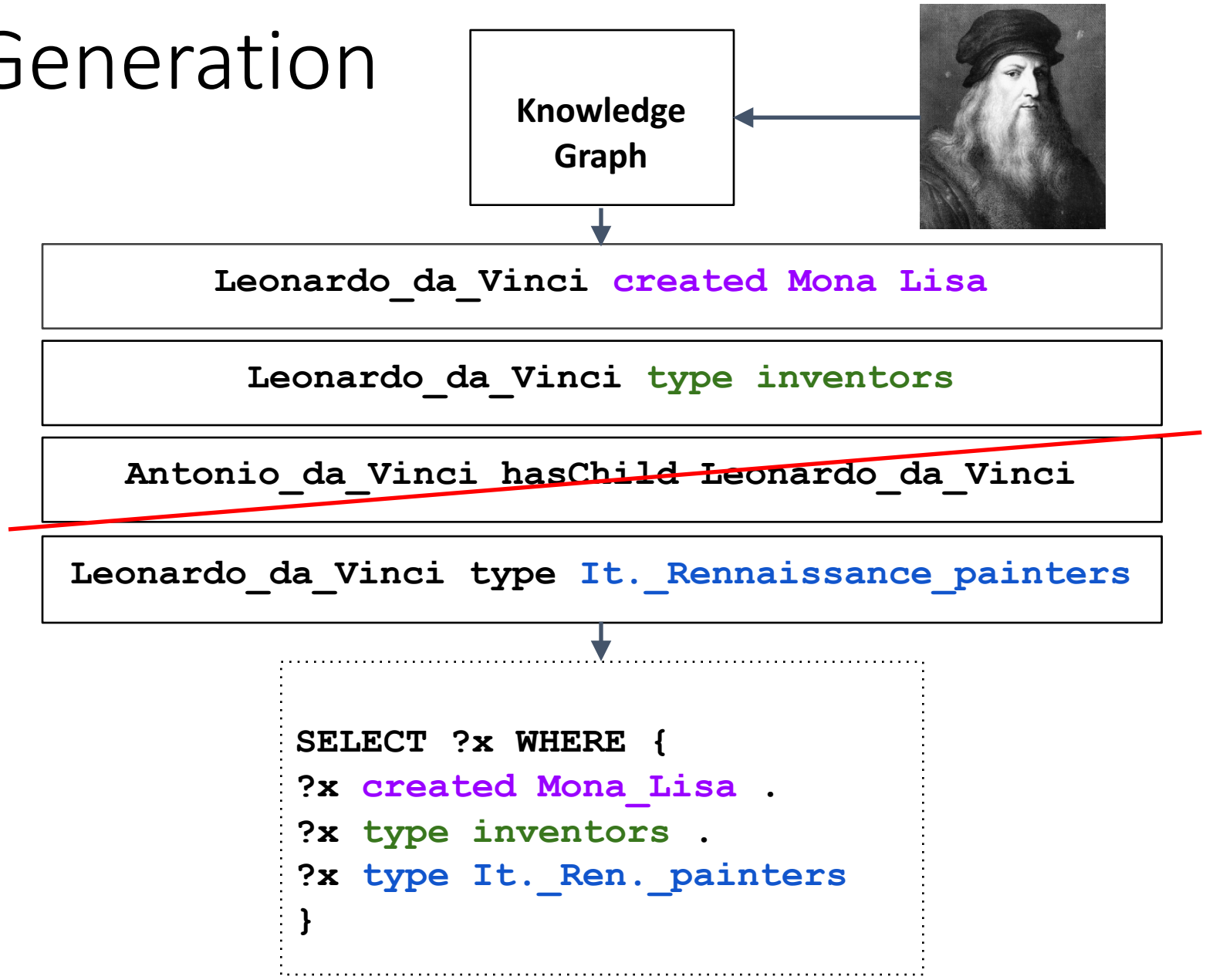
Natural Language Question

Question Generation Pipeline

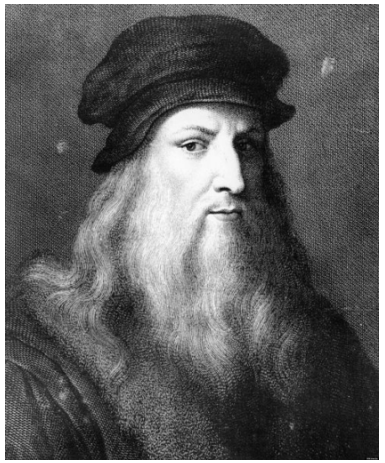


T = Topic (a set of entities related to T)
Q = Question (question and correct answer)
MCQ = Multiple Choice Question (Q with incorrect answer options “distractors”)

Query Generation



Question Difficulty Example



Leonardo da Vinci

easy

```
?x type painter .
?x created Mona_Lisa .
?x created Vitruvian_Man .
?x created The_Last_Supper
```

hard

```
?x type scientist .
?x type engineer .
?x influences Victor_Bregeda .
?x created Portrait_of_a_Musician
```

Question Difficulty Estimation

- Ground Truth: Jeopardy! question – difficulty pairs
  - $200 Question -> Easy
  - $1000 Question -> Hard
- Annotation of entities with AIDA[1]
- Training and evaluation of logistic regression classifier
- Features based on:
  - Entity salience
  - Coherence of entity pairs
  - Entity types

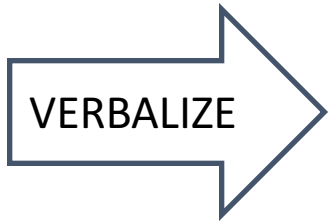
[1] Yosef, Mohamed Amir, et al. "Aida: An online tool for accurate disambiguation of named entities in text and tables." VLDB 2011.

Query Verbalization

- Verbalize using pattern:

Which verbalize(type$_1$), ..., and verbalize(type$_m$)
verbalize(p$_1$,o$_1$), ..., and verbalize(p$_n$,o$_n$)?

```
SELECT ?x WHERE {
?x created Mona_Lisa .
?x type inventors .
?x type It._Ren._painters
}
```

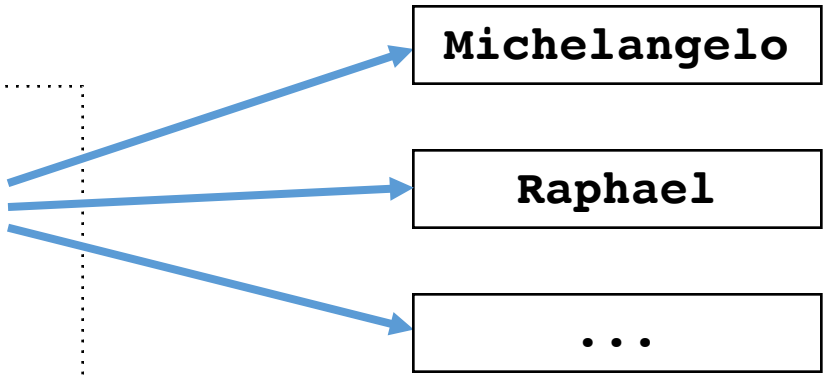


Which Italian Renaissance painter and inventor created Mona Lisa?

Distractor Generation

- Relax Query

```
SELECT ?x WHERE {
?x type It._Ren._painters
}
```



- All but one retrieved entities will be incorrect answers to target query
- Measure "confusability" between answer (e_a) and distractor entity (e_{dist}):

$$conf(Q, e_a, e_{dist}) =$$

$$1 - |P(diff(Q, e_a) = easy) - P(diff(Q, e_{dist}) = easy)|$$

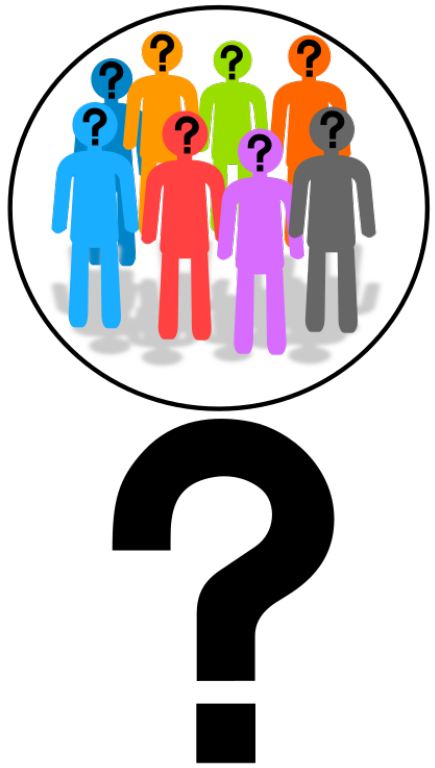
Evaluation: Question Difficulty

SAL	COH	TYPE	Accuracy
yes	yes	yes	**66.4%**
yes	no	yes	65.8%
yes	yes	no	62.6%
yes	no	no	62.2%
no	no	yes	60.0%
no	yes	yes	57.8%
no	yes	no	52.4%
no	no	no	50.0%

1. Evaluation on held-out data with ten-fold cross validation
2. User study to evaluate difficulty ranking of questions - Kendall's τ : 0.593, indicating moderate agreement

Evaluation: Distractor Confusability

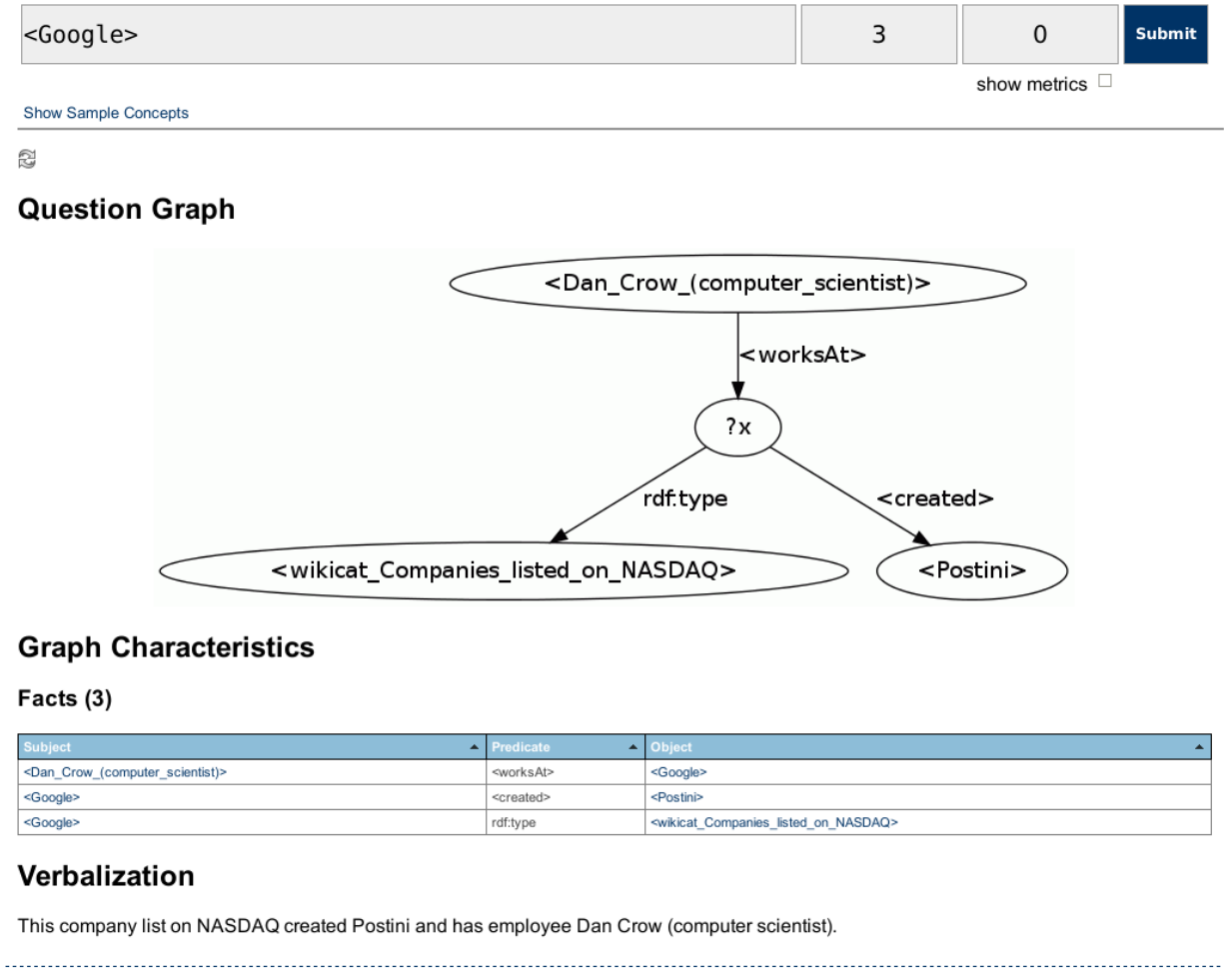
- Crowdsourcing Experiment
- 400 Questions, each evaluated by five judges
- Evaluate whether judges agree with confusability estimate
- 76% of confusability estimates correct
- Cohen's κ of 0.521, indicating moderate agreement



Additional Resources

- Example Dataset: http://bit.ly/kg-questions

- Live Demo: http://bit.ly/kg-questions-demo



Summary

- Question generation applications: Education, Training, Leisure, etc.
- Can be generated on large scale and reduces human workload
- Generate question starting at the answer and retrieve question content from knowledge graph
- Represent question as query over knowledge graph and check for uniqueness of answer
- Train difficulty classifier using entity salience, coherence and type information from Jeopardy! ground truth
- Verbalize query using template
- Retrieve distractor answers by relaxing the question query and measure confusability

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